SIGGRAPH 2003 Course Notes

L-systems and Beyond

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Course Description

L-systems are a biologically-motivated formalism that can be used as a tool for modeling and visualizing biological structures, and as a computing technique gleaned from nature to solve other modeling problems. Their appeal lies in a compact, intuitive description of algorithms, and the possibility of using this description directly as an input to the modeling software. The course will present recent theoretical results, implementations, applications and research directions pertinent to L-systems and their extensions. The applications include, on one hand, the modeling and visualization of plants at different levels of abstraction and for a variety of purposes, and, on the other hand, geometric modeling of curves and surfaces. These applications are united by their treatment of the modeled objects as dynamical structures subject to local operations, and can be implemented using the same modeling software. The course will be of a particular interest to researchers and students working on geometric modeling and the modeling of nature.

Prerequisites

The course will assume basic knowledge of geometric modeling algorithms, in particular subdivision curves and surfaces, and of numerical methods for solving algebraic and (ordinary and partial) differential equations. Prior exposure to L-systems, fractals, and the modeling of plants is desirable, but not necessary.

Speaker Biographies

Pavol Federl is a research associate in the Department of Computer Science at the University of Calgary, where he also received his Ph.D. His graduate work was done under the direction of Dr. Przemyslaw Prusinkiewicz, and involved physically based simulations of fracture patterns. Dr. Federl's current research interests lie in the area of simulating growth in biological structures. He is also involved in the development of Virtual Laboratory (VLAB), an interactive and collaborative simulation environment.

Radoslaw Karwowski is a research associate in the Department of Computer Science at the University of Calgary. He holds an M.Sc. in Computational Physics from the University of Wroclaw, Poland, and a Ph.D. in Computer Science from the University of Calgary. From 1996 to 1998 he worked on the modeling and simulation of plant development in the Institute of Botany at the University of Wroclaw. His current research interests are in the domain of modeling languages and simulation methods applicable to plant modeling. He is a co-creator and developer of the L-system-based plant modeling software L-studio.

Radomir Mech is a technical staff member at SGI, Mountain View, CA. He received a Ph.D. in Computer Science from the University of Calgary in 1997, where he completed a dissertation under the direction of Dr. Przemyslaw Prusinkiewicz. His graduate work was devoted to L-system models of plants interacting with their environment. After his Ph.D., Dr. Mech joined the OpenGL Performer team at SGI, where he developed algorithms enhancing the visual quality of real-time rendering. Dr. Mech is the (co)author of several research papers, including three papers presented at SIGGRAPH. His current research spans real-time rendering and procedural modeling.

Przemyslaw Prusinkiewicz is a Professor of Computer Science at the University of Calgary. He holds an M.Sc. and Ph.D., both in Computer Science, from the Technical University of Warsaw. Before joining the faculty of the University of Calgary, he was a faculty member at the University of Regina, Canada, University of Science and Technology of Algiers, and Technical University of Warsaw. He was also a Visiting Professor at Yale University (1988), l'Ecole Polytechnique Federale de Lausanne (1990), and a Visiting Researcher at the University of Bremen (1989) and the Centre for Tropical Pest Management in Brisbane (1993, 1994, 1998). His research combines computer graphics with concepts rooted in biology, formal language theory, and mathematics. He originated a method for visualizing the structure and growth of plants based on L-systems, a mathematical model of development. He is the co-author of two books, "The Algorithmic Beauty of Plants", and "Lindenmayer Systems, Fractals, and Plants", and numerous papers in this area. He was the organizer of the 1992 SIGGRAPH course on fractals, and a speaker in over 15 other SIGGRAPH courses on fractals, procedural modeling, artificial life, and modeling of natural phenomena. Dr. Prusinkiewicz is the recipient of the 1997 ACM SIGGRAPH Computer Graphics Achievement Award.

Course Schedule

Part 1: Introduction to L-systems

1:45: Introduction to L-systems: theory, modeling, and graphics
Prusinkiewicz

Part 2: Plant modeling with L-systems

2:15 Foundations: simulating control processes in plants
Mech

2:45 Interlude: solving algebraic and differential equations with L-systems
Federl

3:15 Break

3:30 Advanced plant modeling: genes, physiology, and biomechanics
Prusinkiewicz

Part 3: Geometric modeling with L-systems

4:00 Application of L-systems to geometric modeling of curves
Prusinkiewicz

4:20 Extending L-systems to surfaces
Prusinkiewicz

Part 4: Implementations of L-systems

4:40 Designing and implementing an L-system-based language
Karwowski

5:00 Hardware implementation of L-systems
Mech

5:20 Questions and answers
Federl, Karwowski, Mech, Prusinkiewicz

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